Natural selection is the most powerful force driving evolution, allowing the fittest to survive in the ever changing environment. This indicates that only individuals with highest adaptation potential can pass on their genes to the next generation. In their natural environments living organisms interact with a plethora of abiotic (physical and chemical environmental factors) as well as biotic (other living organisms inhabiting a common ecosystem) factors. The majority of biotic interactions are associated with organisms competing for available resources. Over the course of evolution formation of complicated networks (mutualistic interactions) of cooperating organisms turned out to be beneficial and to give the multi-organismal consortia a competitive edge. As an example of the impact that symbiosis had on evolution may serve the symbiosis that lead to the development of eukaryotic cells and the prokaryotic origin of chloroplasts and mitochondria formulated in the “Endosymbiosis Theory” by Lynn Margulis in 1970. Currently, our awareness of the complexity and quantity of microorganisms inhabiting all higher organisms is growing. The role of microbiomes of higher organisms is largely unknown.

Two major groups of microorganisms: bacteria and fungi associate with plants in beneficial and neutral symbiosis. Biomass-wise fungi are the most abundant group of plant inhabitants. The best described group of symbiotic fungi are the root-bound mycorrhizal fungi, which form very characteristic pericarp often found in close proximity to trees which serve as their hosts. Theses “mushrooms” are popular in the food industry. According to available reports mycorrhiza plays an important role in plant adaptation to the environment by attenuating the effects of drought, anthropogenic pollution, improving the efficiency of nutrient and water acquisition from the soil and conferring tolerance against a wide variety of pathogens. Several attempts are being made to utilize mycorrhiza in crop protection strategies. In general these attempts are successful, but mycorrhiza based technologies suffer from numerous limitations. Recently, fungi from other groups then mycorrhiza-fungal endophytes were found to abundantly colonize plant tissues. A very limited number of available reports indicates that these microorganisms may play similar roles in plant biology as mycorrhizal fungi. This fact is particularly interesting since, in contrast to mycorrhiza, endophytic fungi colonize and improve properties of plants from the *Brassicaceae* family. Members of the *Brassicaceae* are import crops (rape, broccoli) as well as plants with a unique ability to withstand high quantities of toxic metals in soils- metalophytes and hyperaccumulators and the model plant, commonly used in basic research Thale cress (*Arabidopsis thaliana*).

The aim of the planned project is to evaluate the possibility of utilizing fungal endophytes, selected in previous studies conducted by the Plant-Microorganism Interactions Group of the Małopolska Centre of Biotechnology (Jagiellonian University) in improving the efficiency of phosphorus uptake by its host plant and to elucidate the molecular mechanisms of the plant-endophyte symbiosis/growth promotion. The development of a technology allowing to improve the described above traits is particularly important due to the rapid decrease in available inorganic phosphate resources. Additionally, improving the efficiency of phosphorus uptake by the plant would allow to limit the use of fertilizers heavily polluted with the highly toxic cadium (from phosphorites). The mechanisms of fungi induced, plant water and phosphate uptake will be examined with state of the art molecular biology methods including RNA sequencing (genome wide expression analysis- RNAseq), molecular cloning and GWAS (*genome wide association studies*). Particular focus will be placed on the mechanisms of endophyte induced root hair elongation. Root hairs are responsible for the majority of plant water and nutrient uptake, thus understanding the mechanism of increasing the root absorption area seems of particular significance. Additionally, the generation of fungi strains constitutively expressing fluorescently labeled proteins (R/GFP-*red/green fluorescence protein*) will allow to precisely locate the fungi inside plant tissues, what combined with transcriptomic data is necessary to describe the biology of the fungal endophyte and the plant-fungi symbiosis in general. Preliminary studies performed in our lab indicate that plant hormones ethylene (ET) and strigolactone (SL) play an important role in in the interaction between the plant and the endophytic fungus. In the planned research it is planned to verify the role of these two signaling molecules in the plant-microbe interaction, particularly their role in fungi dependent adaptation to drought and phosphorus deficiency. The results of the project will allow the possibility of limiting fertilizer and water use in cultivation of crops.